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37. Please cancel claim 37.

38. Please cancel claim 38.

REMARKS

Examiner Hsien-Ming Lee is thanked for thoroughly reviewing the instant application and for examining the Prior Art.

Examiner is also thanked for the indication of allowing claims 1-14 and for allowing claims 19-21, 23-25, 32, 33, 39 and 40 if these claims are rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 37 and 38 have been cancelled in view of double patenting limitations, these two claims are duplicate of claims 26 and 27.

Claim 15 has been amended by limiting the partial removing of the contact pad to using a mask of passivation material for this removal (quote from amended claim 15: partially removing said contact pad in accordance with a mask of passivation material).

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This mask of passivation material has been previously specified in dependent claim 19, no new matter is therefore introduced by the amendment to claim 15. This makes amended claim 15 different from claim 10 of U.S. Patent 6,426,556 B1 since this latter claim does not depend on the limitation of using a mask of passivation material for the etching of the contact pad.

Claims 16-23 are dependent on claim 15, placing these claims also in patentable form.

Favorable reconsideration of this application in light of the above amendments and the following remarks is respectfully requested.

A new method is provided for the creation of metal bumps over surfaces of I/O pads. Contact pads are provided over the surface of a layer of dielectric. The aluminum of the I/O pads, which have been used as I/O pads during wafer level semiconductor device testing, is completely or partially removed over a surface area that is smaller than the surface area of the contact pad using methods of metal dry etching or wet etching. The contact pad can be accessed either by interconnect metal created in a plane of the contact pad or by via that are

provided through the layer of dielectric over which the contact pad has been deposited. The process can be further extended by the deposition, patterning and etching of a layer of polyimide over the layer of passivation that serves to protect the contact pad.

Specifically, the invention provides for:

- etching a contact pad, using a layer of passivation as a mask, partially or completely removing the contact pad from above a layer of dielectric, whereby the opening created in the contact pad has a depth that is less than or equal to the height of the contact pad, and
- forming a metal bump over the etched contact pad.

Drawings

Reconsideration of the objection to the drawings is respectfully requested based on the following.

Fig. 18b has been amended by removing the intact portion of layer 33 on the left of the bump metal 35.

In light of the foregoing response, applicant respectfully requests that the Examiner's objection to the drawing be withdrawn.

Specification Objections

Reconsideration of the objections to the specification is respectfully requested based on the following.

The first paragraph on page 1 has been amended by adding the statement "now U.S. Patent 6,426,556" to this paragraph.

In light of the foregoing response, applicant respectfully requests that the Examiner's objections to the specification be withdrawn.

Double Patenting

Reconsideration of the Double Patenting rejection of claims 26, 27, 37, 38 and 15-23 is respectfully requested based on the following.

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Regarding claims 26, 27, 37 and 38:

Claims 37 and 38 have been cancelled in view of double patenting limitations, these two claims 37 and 38 are identical to claims 26 and 27.

Regarding claims 15-23:

Claim 15 has been amended by limiting the partial removing of the contact pad to using a mask of passivation material for this removal (quote from amended claim 15: partially removing said contact pad in accordance with a mask of passivation material).

This mask of passivation material has been previously specified in dependent claim 19, no new matter is therefore introduced by the amendment to claim 15. This makes amended claim 15 different from claim 10 of U.S. Patent 6,426,556 B1 since this latter claim does not depend on the limitation of using a mask of passivation material for the etching of the contact pad.

Claims 16-23 are dependent on claim 15, placing these claims also in patentable form.

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In light of the foregoing response, applicant respectfully requests that the Examiner's Double Patenting rejection of claims 26, 27, 37, 38 and 15-23 be withdrawn.

Claim rejections - 35 U.S.C. § 102

Reconsideration of the rejection of claims 15-18 and 22 under 35 U.S.C 102(e) as being anticipated by Lin (U.S., Patent 6,426,556 B1) is respectfully requested based on the following.

Claim 15 has been amended by limiting the partial removing of the contact pad to using a mask of passivation material. This mask of passivation material has been previously specified in dependent claim 19, no new matter is therefore introduced in the claims.

This makes amended claim 15 different from claim 10 of U.S. Patent 6,426,556 B1, since this latter claim does not depend on this limitation. Claims 16-18 and 22 are dependent on claim 15, making these claims unique and placing these claims in patentable form.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of claims 15-18 and 22 under 35 U.S.C 102(e) be withdrawn.

Claim rejections - 35 U.S.C. § 103

Reconsideration of the rejection of claims 26, 27, 37 and 38 under U.S.C. 103(a) as being unpatentable over Lin (U.S., Patent 6,426,556 B1) is respectfully requested based on the following.

The rejection of claims 37 and 38 is considered moot since claims 37 and 38 been cancelled.

The AAPA shows in Fig. 1a an aluminum contact pad, the circumference of a metal bump overlying aluminum contact pad, the circumference of the opening created in the protective layer of passivation and a probe mark caused by a tester probe (not shown) in the surface of aluminum contact pad.

Further, the AAPA shows, in Fig. 1b, a layer of dielectric deposited over the substrate, a layer of passivation deposited over the layer of dielectric an opening created in the layer of passivation, a layer of under-bump-metal (UBM) overlying the

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aluminum pad, a layer of metal that forms an integral part of the pedestal of the metal bump and the metal bump created overlying the aluminum contact pad.

What the AAPA therefore does not show and as specified in claim 15 of the invention to which claims 27 and 28 are dependent claims, is that the contact pad is partially removed, the removing having a thickness and a removal surface area, with the objective of removing a probe mark caused by a tester probe in the surface of aluminum contact pad. AAPA highlights the occurrence of a probe mark, the invention provides for the removal of this probe mark without thereby specifying how the contact pad, in which the probe mark is present, is further interconnected or accessed. Claims 26 and 27 provide these specifications for the contact pad in which, as specified in claim 15 to which claims 26 and 27 are dependent claims, the probe mark is removed by the invention.

Claim 15 has been amended by limiting the partial removing of the contact pad to using a mask of passivation material for this removal (quote from amended claim 15: partially removing said contact pad in accordance with a mask of passivation material).

Since all the claims within this rejection are dependent upon amended claim 15 and carry all of the limitations of amended claim 15, applicant additionally asserts that those remaining claims may not also properly be rejected under U.S.C. 103(a) as being unpatentable over Lin (U.S., Patent 6,426,556 B1), for reasons cited by the examiner.

In light of the foregoing response, applicant respectfully requests that the Examiner's rejection of 26, 27, 37 and 38 under U.S.C. 103(a), be withdrawn.

Other Considerations

No new independent or dependent claims have been written as a result of this office action, no new charges are therefore incurred due to this office action.

SUMMARY

A new method is provided for the creation of metal bumps over surfaces of I/O pads. Contact pads are provided over the surface of a layer of dielectric. The aluminum of the I/O pads, which have been used as I/O pads during wafer level semiconductor device testing, is completely or partially removed

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over a surface area that is smaller than the surface area of the contact pad using methods of metal dry etching or wet etching. The contact pad can be accessed either by interconnect metal created in a plane of the contact pad or by via that are provided through the layer of dielectric over which the contact pad has been deposited. The process can be further extended by the deposition, patterning and etching of a layer of polyimide over the layer of passivation that serves to protect the contact pad.

It is requested that should Examiner not find the claims to be allowable that he call the undersigned Attorney at his convenience at 845-452-5863 to overcome any problems preventing allowance.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned:

"Version with markings to show changes made."

Respectfully submitted,



Stephen B. Ackerman (Reg. No 37,761)

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Version with markings to show changes made

IN THE SPECIFICATION

1) page 1, first paragraph, please replace this paragraph with the following:

This application is related to attorney docket number MEG01-001, filed on 01/16/01, serial number 09/760,909, now U.S. Patent 6,426,556, assigned to a common assignee.

IN THE CLAIMS

Please amend the claims as follows.

15. (Amended) A method for forming a metal bump on a semiconductor substrate, comprising the steps of:

providing a semiconductor substrate, said semiconductor substrate having been provided on the surface thereof with a contact pad, said contact pad overlying a layer of dielectric, said layer of dielectric having been deposited over said semiconductor substrate; and

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partially removing said contact pad in accordance with a mask of passivation material, said removing having a removal thickness and removal surface area.

19. (Twice Amended) The method of claim 15 wherein said partially removing said contact pad in accordance with a mask of passivation material comprises the steps of:

depositing a layer of passivation material over the surface of said layer of dielectric, including the surface of said contact pad;

patterning and etching said layer of passivation material, creating an opening in said layer of passivation material having a first diameter, partially exposing the surface of said contact pad over a surface area of said first diameter, said first diameter of said opening created in said layer of passivation material being smaller than a surface area of said contact pad by an amount; and

etching said contact pad, using said patterned layer of passivation material as a mask, creating an opening in said contact pad having a second diameter, partially or completely first removing said contact pad from above the surface of said layer of dielectric, said second diameter of said first opening created in said contact pad being about equal to said first

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diameter of said opening created in said layer of passivation
material.

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